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# Predicting peak of participants in collective action

Peng Lu[a,b,*]

[a] Department of Automation, Tsinghua University, China
[b] Department of Sociology, Tsinghua University, China

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ABSTRACT

In terms of the number of participants, almost each collective action has a life cycle where the number grows from zero to its peak where its maximum potential power or influence is acquired, then it decreases to zero eventually. Therefore, we concentrate on modeling, simulating, and predicting the peaks. The model is constructed based on previous models, and the data is collected from simulations. Preliminarily, it suggests that there exists a peak for collective action when its "jointness of supply" is less than one. Under complete homogeneity, the ideal peak is calculated and the ideal peaks function (IPF) is obtained. Then, heterogeneity is introduced into to the model, and the form of real peaks function (RPF) can be obtained based on simulations and statistical methods. For those who intend to organize a collective action and increase the peak of participants should take measures, such as ideology, leadership, and propagation, to enhance homogeneity or try to reduce heterogeneity.

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## 1. Introduction

As a fundamental phenomenon in social sciences, collective action refers to that people act together to achieve a specific collective goal [1], such as strikes and protests. For its societal impact and political implications [2–4], three approaches have been applied to explore collective action so far: (a) the theoretical approach refers to theoretical analysis based on observations or case study [5–17]; (b) the empirical approach refers to the statistical models on empirical data [2,18–26]; and (c) the mathematical approach refers to the application of formal or mathematical models and simulations to unveil properties of collective action [27–34]. This work follows the paradigm of formal models, where several typical models have been applied to investigate collective action, such as the threshold model [35,36], standing ovation model [37], network model [38–41], stochastic learning model [42–47], critical mass model [48–50] or freezing period model [51], game theory model [52–56], etc. Simulations are applied to test the credibility and draw conclusions of formal models.

It is interesting that each collective action owns a life circle containing a peak in terms of the number of participants, no matter how influential it is and whether the goal is achieved or not. Despite the importance and myriad applications of collective action, few scholars have solved the peak mechanism of participants. Depending on different cases, the peak varies in the real world. Some are hundreds, such as Peasants Petitioning for a redress of grievances during 2010 and 2013 in China[1]; some are thousands, such as Attacking Policemen Incident in Shenzhen (2010) in China, where thousands of angry pedestrians attacking

* Corresponding author at: Department of Automation, Room 813, Main Building, Tsinghua University, 100084 China. Tel.: +86 188 1175 9063/+86 10 6278 1475.

*E-mail address:* lvpeng.tsinghua@hotmail.com

[1] It is reported by mainstream news agencies in China that hundreds of farmers or peasants kneeling at the door or yard of local governments to beg the redress of their grievances. These cases can be found at the following websites addresses. http://bbs.news.163.com/bbs/photo/182401265.html; http://club.china.com/data/thread/1011/2737/62/85/0_1.html; http://opinion.hexun.com/2010-05-21/123765627.html.

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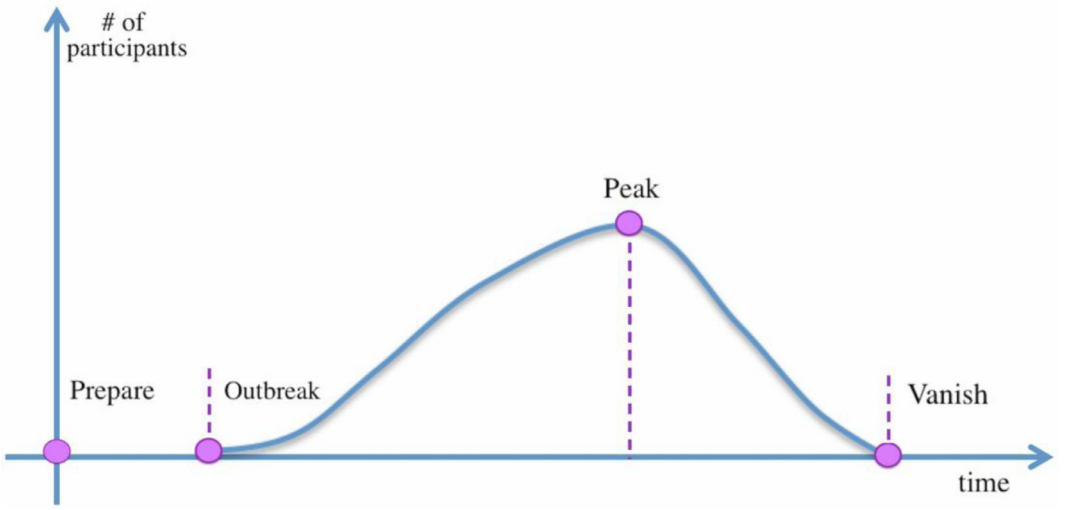


**Fig. 1.** *The life cycle of collective action*. It contains four turning points, prepare, outbreak, peak, and vanish. At the prepare point, no one participant but some are preparing for it; after the outbreak point, participants are present and increase; then the number climbs to its maximum at the peak point after a dynamic decision and complex interaction; after that, the number decreases and towards zero until the vanish point.

policemen randomly on the street[2]; some are tens of thousands, such as the Teachers' Serial Strikes in Sichuan of China (2008)[3]; and the peak reaches several millions for online collective actions[4].

Although predicting the peak is hard for the complexity of collective action and heterogeneity of individuals [35,57], relevant discussions and clues still exist. Initially, the paradox of group size was pervasive that larger group reduces the number of participants [1,58]. Later researches indicate that the paradox can be fixed by the "jointness of supply", which measures how each agent's payoff be affected by the number of total people that share the outcome of collective actions. If a collective action has "pure jointness of supply", the increase of people sharing the outcome will not cause the decrease of individual payoff and the paradox is solved [49]. While the paradox is caused by "pure jointness of supply" where the individual payoff decreases as the group size grows. Binary values of $J$ (0 or 1) are not enough to capture features of all the possible collective actions. Macy expands the $J$ to the unit interval unit interval [0, 1] and makes it continuous [42–44]. Simulation shows that $J$ does increase the number of participants and facilitate the emergence of critical mass [48].

The peak is significant in studies of collective action. It is believed that "a mobilization with higher numbers of people with higher levels of extraversion has a higher chance of success" [51,59]. Hence, the number of participants indicates the power, influence, and pressure. As the climax, peak usually brings the biggest power, largest influence, and therefore highest success rate. At the peak, participants and resources cannot increase any more, showing the strongest power to force opponents, such as government, to compromise. The success rate is much higher than otherwise. The collective action is unlikely to achieve its goal when it doesn't even succeed at the peak.

Therefore, the aim of this paper is to explore the condition of peaks and predict them. An expanded model will be constructed to focus on the condition and how to predict peaks. The Domain of $J$ is enlarged to the real number $R$ to investigate the condition of peaks. If the peak exists, the ideal peaks function (IPF) is acquired under complete homogeneity. Combined with simulation and statistical methods, the real peaks function (RPF) can be obtained, with IPF as the benchmark. The real peak is determined by several parameters or factors, and implications of them will be discussed as well.

## 2. Life cycle of collective action

The peak is from observations of real cases. In terms of the number of participants, collective actions share the same life circle pattern, which is shown by Fig. 1. The prepare point is unobservable. This whole process containing four turning points is called the life cycle. Tons of examples follow this regularity, such as Attacking Policemen Incident (China, 2010), the Arab Spring Movements (2010–2011), Occupying Wall Street (USA, 2011), Yuyuan Strike (China, 2014), and Occupying Central Circle (HK, 2014). Peak-less collective action has not been seen. Take the Attacking Policemen Incident as an example. Before it, local

[2] It is reported by Xinhua News Agency that when enforcing the laws a traffic policeman caused the death of a motorcycle driver by mistake, and this enraged many passersby so they punished the policeman group by attacking them randomly and fiercely. This case can be found at the following URL. http://news.ifeng.com/mainland/200811/1108_17_868581.shtml.

[3] This serial event of teachers' strikes was pervasive in many counties of Sichuan Province. Teachers were reluctant to teach any classes because their salaries or incomes were much lower than local civil servants (gongwuyuan). http://news.ifeng.com/society/5/200811/1126_2579_895371_2.shtml.

[4] Such as in the Jiajunpeng Incident, the peaks are about 3 millions and the total amount of participants are 40 millions. http://baike.baidu.com/link?url=lWxjLD0XlRXWKSojbQssXIsflA_ART3ZSKwRoEXK5dWB1QkxVcyMyvuh-1L1o0ajw0QHgkAistn34p95CUExW_.

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